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Stephanie S. Turner

Re-imagining Extinction

Projects to recuperate lost and endangered species proceed from culturally specific wants and needs dramatized in popular accounts of science, often resembling the narratives of other cultural forms, such as novels and film. For example, researchers involved with the Mammoth Creation Project, a privately funded Japanese initiative with backing from the Russian government, are attempting to clone a woolly mammoth or, if that fails, recreate a mammoth/Asian elephant hybrid through back breeding using viable sperm or DNA extracted from woolly mammoth carcasses excavated from the Siberian tundra.[1] This creation is slated to be a key attraction in Pleistocene Park, a Siberian wilderness preserve twice the size of Japan that would enable scientists to study climate change by recreating Ice Age flora and, ideally, some of its fauna.[2] These and similar recuperation efforts resonate in popular culture, referencing fiction like *Jurassic Park* (1991), *The Pleistocene Redemption* (1997), and other tales of experimental breeding and the revivification of prehistoric DNA.[3]

Together, Pleistocene Park and the Mammoth Creation Project typify scientific visions of recuperating extinction through reproductive and genetic technologies. When scientists imagine restoring endangered species and recently extinct populations, they evince some of the same storytelling elements cultures use to explain their origin, identity, and destiny. The scientific mystery surrounding recent species extinction coincides with the contested story of human evolution, and so it necessarily engages various explanations touching on a range of human

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concerns—from who we are to where we have been and where we are going—that are at once biological, geopolitical, and historical. In the classic paleontological account of the impact of the new species *Homo sapiens* on the natural world, early modern human beings resemble roving bands of thugs, with their ability to use language, work together in groups, and plan ahead, migrating out of east Africa across Europe and Asia and terrorizing their more complacent relatives, *Homo neanderthalensis*.[4] According to paleobiologist Michael Boulter, the major source of conflict was less a matter of competition for resources than it was a difference in temperament between the two hominid species: *Homo sapiens* was, and remains, the most aggressive and selfish of species.[5] Not only is it still debatable whether *Homo sapiens* drove the Neanderthals to extinction, but the question of whether and how early human beings might have contributed to the extinction of Pleistocene fauna like the woolly mammoth also remains unanswered. The goals of Pleistocene Park demonstrate the scientific complexity and human drama underlying these questions.

According to Sergey Zimov, director of the project, one objective is "to determine more precisely the role that Pleistocene animals [like mammoths, woolly rhinoceroses, horses, and reindeer] played in maintaining their own ecosystem."[6] In an effort to simulate pre-contact times, researchers plan to stock the anachronistic ecosystem with recreated or related fauna, minimize human impact, and then observe what takes place. Conspicuous by their absence from the Pleistocene Park drama are its human actors. Zimov's explanation falls into line with the classic paleontological account: "Starting with unpretentious ambitions to survive in a hostile environment, *Homo* [*sapiens*] ended up assuming the powerful role of ecosystem terminator. The mammoth ecosystem was the first large-scale victim."[7] Zimov's rhetoric of violence underscores the cultural aspect of poor human stewardship of the natural world, whereby human beings systematically destroy both habitat and inhabitants. As a remedy to the destruction, in the recuperation drama of Pleistocene Park, human beings would be passive observers, not aggressive intruders.

Restoration projects like Zimov's challenge the "naturalness" of natural history, suggesting that human beings have played a key role in writing it and, more significantly, urging that we revise it through whatever means we have available, be it international treaty or interspecies embryo transfer. The role of genetic science is foundational to these projects. Through various techniques of DNA analysis, genetic conservationists are now articulating species evolution with mathematical

precision,[8] applying a "calculus of biodiversity"[9] to determine which species are most at risk of extinction. Yet, despite the great accuracy of genetic science, restoration projects are also deeply ambivalent, reflecting unresolved conflicts between the scientific community and the public. The efforts of the 109th Congress to roll back provisions of the Endangered Species Act of 1973 (ESA) exemplify this ambivalence. In this policy document, certain inhabitants of a geopolitically delimited environment are identified as "threatened"[10] or "endangered"[11] and on that basis granted a sort of protected citizenship status as an intrinsic part of "the Nation's heritage"[12] without which the public would suffer an "esthetic, ecological, educational, historical, recreational, and scientific"[13] loss. Taking momentum from President Nixon's signing the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1973,[14] the ESA established the United States as a leading nation in treating its natural resources as a cultural legacy. Recently, however, protections for endangered species were reevaluated by U.S. lawmakers who sought to redefine the "critical habitat" provisions outlined in the ESA.[15] The *Critical Habitat Enhancement Act of 2005* would have narrowed the definition of "critical habitat," restricted the nation's natural resource heritage, and limited the scope of what is meant by "loss" to enable a broader use of land by developers. Zimov's rhetoric of human violence against the natural world echoes in the negative implications of this legislation for endangered species survival, with elected officials serving as the "ecosystem terminators."[16]

Countervailing responses to endangered species thus hinge on a dialectic of peril and recovery in which human cultures negotiate with each other, and with the natural world, for survival. Two key features of this dialectic are the shortness of human existence in geologic time and the inevitability of extinction for most species, without which evolutionary change would not be possible.[17] In the 3.4 billion-year history of life on earth, hominids have existed fewer than 8 million years, with *Homo sapiens* existing for only 300,000 to 500,000 years. This knowledge of our relatively brief history, coupled with a general agreement that a sixth mass extinction is currently underway,[18] accounts for a growing concern about the implications of biodiversity loss for human beings. Unlike the first five, much of the current mass extinction is anthropogenic, and it may, ironically, place *Homo sapiens* on the endangered list. Because of its anthropogenic aspect, it is necessary to view the dialectic of peril and recovery by which extinction narratives are undergoing revision in literary terms, as an apocalyptic mode of expression: extinction is an unimaginable endpoint in the drama of the

threatened and endangered; it resists representation because, as narrative theorist James Berger observes in his study of the literature of the Holocaust and other historical crises, we cannot imagine an ending without also imagining what happens after it, that is, the recuperation of the loss.[19] The apocalyptic mode of expression is thus in essence utopian, an "imperative to imagine radical alternatives," as Fredric Jameson has described it.[20] Such thought experiments have the power both to delude and to inspire.

In extinction narratives, one effect of the endpoint's resistance to representation is the tendency of the concept of extinction itself to disappear, as it seems to do in the proposed legislation to amend the ESA. For example, unlike the ESA, the *Critical Habitat Enhancement Act of 2005* does not use the word "extinction." Nevertheless, intervening in species endangerment is contingent upon the distinctive threat of extinction, an unambiguous condition of non-existence that can be proven in the fossil record and is further substantiated by genetic science. Increasingly, the fossil record is being treated as a genetic record, as researchers identify intact DNA preserved in permafrost and even in temperate sediments.[21] Indeed, historically significant DNA can be found everywhere and is being preserved by researchers in many ways and for many uses. DNA has also proven to be viable across various media, from geological sediment to computer databanks,[22] leading new media theorist Eugene Thacker to develop a distinction between genetic information *in vivo*—what the biological, biomolecular species or patient body can tell us—and genetic information *in silico*—what we can further understand about an organism and its environment through computerized visualizations, databases, and simulations derived from the genetic code.[23]

In narrative terms, the bodiless, multi-medial viability of DNA can be understood as a function of "genome time." In his analysis of the impact of genetic science on narrative, Jay Clayton observes that it has brought forth a "distinctive attitude toward time" that "paradoxically takes an eschatological stance toward the future" while revising evolution as a biological story into a narrative that can be altered to suit cultural imperatives.[24] In the "perpetual present" created by the infinite mutability of this narrative, "the present is made to contain every possible permutation of time as a suddenly legible system of signs."[25] For extinction narratives, the development of molecular biology means that species like woolly mammoths and Neanderthals are not lost after all, but continue to exist as the genetic codes residing in their remains, codes we are getting better and better at reading and

interpreting. Clayton's notion of genome time, which he locates in both utopian and dystopian narratives, builds on Berger's and Jameson's analyses of the regenerative apocalypticism of historical crisis. In genome time, evolutionary histories, including extinction narratives, are revised, forestalling or even reversing absolute endpoints in the endless reproducibility of the DNA code. While the extinction of long-gone species remains an undeniable ending, the endless reproducibility of DNA renders all extinction open-ended. Both conceptually and informatically (that is, in terms of the posthumous existence of the genetic code in a computer database), extinction is becoming less and less absolute.

The notion that we can recuperate recently lost species through precise applications of the "suddenly legible system of signs" in the genetic code is a productive framework with which to investigate the open-endedness of extinction. The ways this notion manifests in scientific and popular accounts offers a glimpse into the broader cultural changes in our conceptualization of time, indicating an emerging understanding of human accountability, both in the sense of how we recount the past and in the sense of how we account for our continuing impact on the natural environment. Arising from the "perpetual present" of genome time, this phenomenon articulates mythic elements in extinction studies, such as nostalgia for an idealized past, the association of homeland with destiny, the perilous quest for the rare beast, and ritualized atonement for transgression. Indeed, genome time itself is mythic. Fabulous and primal, it characterizes the DNA molecule as the *ne plus ultra* unit of life, establishing a worldview that naturalizes immortality as an inherent, coded quality. The mythic turn brought about by the suddenly legible system of DNA signifiers, these "large datasets of biological information," effable though complex, makes research on extinction subjective, a return to what Boulter calls "the state of mind where we worked with mystery and uncertainty."[26]

In the context of the dialectic of peril and recovery I have outlined, I examine here the role that genetics-based stories play in opening up the apparent dead end of extinction. I first identify the mythic roots of conservation efforts and then trace their development in three extinction narratives: the now-defunct Tasmanian tiger restoration project at the Australian Museum, Richard Stone's documentary *Mammoth* (2001), and Julia Leigh's novel *The Hunter* (1999). My examples include the rationales offered by scientists and conservationists for using the preservation methods of genetics to recover a particular species as well as the dramatization of these methods in documentary and novel forms. I examine how mythic elements such as the quest for a rare beast

under harsh conditions in remote lands and the redemption of human transgression of the natural order through the miraculous recreation of an animal hunted to extinction reflect current cultural anxieties and agendas about the influence of human technology upon the natural order. My primary question is: How do these narrative accounts of the impact of genetic science on lost species reflect the way human beings are rethinking their place in history and their relationship with other species—and, more pointedly, reevaluating their own role as a species with a limited lifespan in natural history? The premise of my analytical method is that the cultural impact of genetic science can best be understood when examined across cultural forms, from scientific hypotheses to adventure science documentaries to science fiction and fantasy novels. As society grapples with the ways genetic science is altering concepts like "the natural," "the human," and "the other," and of "immortality" and "death," the narrative mode in such varied forms illuminates some of the conceptual tools we are using to define and adjust to these changes.

Wilderness Preservation and Genome Time as Mythic

Implicit in genome time is the notion that what is essential about a given organism, what defines it, is inherent in that organism's genetic code. This notion is evident in wilderness preservation projects such as Pleistocene Park, which is informed in part by the genetic relatedness of contemporary and prehistoric species.[27] Yet "wilderness" is a cultural notion, not a quality inherent in the land. Likewise, the apparent essentiality of genome time is complicated by genetic variability within species and the genetic responses of species to their environments. Wilderness preservation and genome time share mythic aspects. Historically, the concept of wilderness arose from European romanticism's formulation of the sublime, the terrible beauty of the natural order that only a particular aesthetic of the landscape could negotiate. Wilderness preservation operates under this aesthetic, an idealization of natural forces as divine and our human experience of them as transcendent. What makes this formulation of wilderness preservation so compelling is that it falls into line with the Western religious tradition of human beings, through original sin, exerting a corrupting influence upon the natural order and attempting, through reconciliation with the divine, to recuperate it—in effect, to restore the sublime.

What Clayton refers to as "the impersonal time of the gene" functions as an ideal, "the code, complete and self-sufficient, run[ning]

through and beyond the individual, reaching back to the first primordial cell and forward to whatever future the species may encounter."[28] While most conservation measures domesticate the natural, wilderness preservation measures do so in a metaphysical mode characterized by a strongly moral sensibility. Arising from a platonic idealization of the natural, they attempt to reestablish the equilibrium that existed before human beings were able, through their tools, to leave a lasting trace on the land. Conservation and preservation efforts are, in short, efforts to make right, through new technologies, the unintended wrongs resulting from older technologies. In this sense, they function as restorative efforts rooted in the Western tradition of understanding history as a continuum, with a beginning and an ending in which human beings play the role of *imago dei*. To be ready for the ending, we must restore the beginning. Zimov's plan for Pleistocene Park, though modest on the surface, strongly dramatizes the mythos of human beings standing in for the divine in caring for nature, including the salvific work of recreating it. Gene banking, with its salvific dimension, both supports and revises this view of history.

Gene banks are established for a variety of theoretical and practical purposes: to catalog species for posterity, to assess species biodiversity, to assist conservation and repopulation efforts, and to research ways genetic materials can be used in agriculture and medicine. Time, once thought to be running out for endangered species, has shifted to a holding pattern in the preservation of the genetic code. While it is not yet clear what future these species may encounter, a future of some sort is now guaranteed. Habitat, too, is shifting, both conceptually and literally. The limited habitat in which endangered animals dwell has now expanded to include the laboratory freezer. The Frozen Zoo® Project at the Center for Reproduction of Endangered Species in San Diego is the largest such repository of rare animal cell lines and DNA.[29] Unlike traditional breeding practices, the genetics-intensive archiving and reproductive techniques enabled by gene banks challenge the definition of "species" as a genetic population that can successfully interbreed. More than merely modifying a particular bloodline or diversifying a gene pool, these techniques have the theoretical potential to render an entire species both chronologically and morphologically malleable. In this sense the frozen zoo is a preservationist and genome time ideal, allowing notions of time and matter to be altered to fulfill cultural needs.

Efforts to recuperate extinction crises by restoring the natural order exemplify the technological progress narrative that commentators

like Donna Haraway have described as entrenched in Judeo-Christian mythology.[30] Scientists and others are thus revising the apocalyptic narratives of endangerment and extinction to make continuity and even immortality possible, yet they are doing so by engaging familiar tropes and metaphors. The idea of "cloning Noah's ark,"[31] for example, puts a familiar spin on species restoration efforts that might otherwise seem strange or dubious to the average zoo-goer. The Ark, of course, was "the dominant metaphor for zoos in the twentieth century," as Nigel Rothfels points out;[32] a cloned Ark perfectly extends this metaphor into the genome time of the twenty-first century, naturalizing immortality by replicating the genetic codes of the representative breeding pairs saved from the Flood. In this and other ways, the historical revisionism brought about by advances in reproductive and DNA science is made recognizable, even familiar. In the potent mythos of genome time, the possibility of "resurrecting" species trumps the fact that in doing so, something entirely different is created. This difference is as much a cultural issue as it is a scientific one.

Family Reunions: Mammoth and Thylacine Revival Tales

The dual goals of reconciling difference and establishing familiarity are prime emphases in lost species revival tales. Extinction reversal stories manifest mythically as family restoration dramas, "family" in this case signifying both taxonomical and cultural categories. The prospect of resurrecting the dead species promises to fill a gap in the family tree, as when bringing back the woolly mammoth is said to be "reuniting" it with its two surviving family members, modern Asian and African elephants.[33] Scientifically, this reunion would answer questions about the Elephantidae family, of which the woolly mammoth is believed to be a member. Culturally, it would atone for what some scientists believe is one of the earliest instances of anthropogenic extinction, the systematic hunting of the mammoth for its meat and fur by early *Homo sapiens*. As with scientific problems, cultural issues also lead to more questions, suggesting the apparitional and numinous: What about the others? Where have they gone, and can they, too, be brought back? One identified gap seems to beget another, and another, such that the ghost of the woolly mammoth conjures that of the woolly rhinoceros and then of the steppe bison and so on, until all the lost fauna of the Pleistocene era rise up from their graves for a mass haunting of both the popular and the scientific imaginations.[34] Could Russians once

again co-exist with these creatures? It seems entirely likely, since for every ancient ghost there is at least one contemporary relative: the white rhinoceros for the woolly and the wood bison for the steppe, to cite just two examples. So the family restoration drama is both an attempt to answer evolutionary questions among scientists and an anthropomorphizing gesture to recuperate the mammoth into natural history as told by human historians. The question of why all the Siberian woolly mammoths, along with their North American "cousins," the mastodons, died out at the end of the Ice Age remains open in the scientific community.[35] The effort to resurrect the mammoth, even if it doesn't succeed, might at least help answer it.[36] And if the effort does succeed, the cultural implications are significant: Russian science (with help from Japan) would be vindicated, and the human disruption of the natural world would be partially rectified.

As the restoration scenario surrounding Tasmania's flagship animal, the thylacine, makes clear, the more recent the animal's extinction, the greater the human stakes in atoning for its loss. Considered by Tasmanians to be "an enduring symbol of Tasmania,"[37] the reason for the Tasmanian tiger's extinction in the mid-twentieth century is inarguable: in the words of the Thylacine Museum™ curator C. Campbell, it was "a genocidal assault" by human beings.[38] Indeed, the bounty placed on thylacine hides by 19th-century Tasmanian colonists codified the mass killing. The anthropogenic extinction of what was once Australia's largest carnivorous marsupial is thought to have occurred in two waves, first on the mainland with the introduction of the dingo and then on the island of Tasmania because of the animal's appetite for the colonial ranchers' sheep and chickens.[39] Now, according to the Australian Museum's former director Mike Archer, the people of Australia have a "moral obligation" to restore the thylacine to life.[40] This obligation gains statutory power from Tasmania's Threatened Species Protection Act of 1995. Thus, the thylacine's story illustrates the nationalist account of reviving a geopolitically representative non-human, an important strain of the family restoration drama of extinction reversal narratives.

Although the Tasmanian government ceased funding thylacine searches in 1995,[41] a zealous corps of Tasmanians remains hopeful that they will spot one in the wild and perhaps capture it, if only on film or digitally. Unsubstantiated sightings are numerous[42]—so numerous, in fact, that an unofficial "National Thylacine Day" was declared on 7 September 1996 to mark the 60th anniversary of the death of Benjamin, the last known thylacine, who died in captivity in the Hobart Zoo. Thylacine-loving Tasmanians observed National Thylacine Day by

quietly camping out, cameras ready, where thylacine sightings have been frequent. In such thylacine artifacts as the alleged paw prints in the Tasmanian wild and the brief black-and-white film showing Benjamin, pacing alone and restless in his[43] cage, the abject ambiguity of extinction resides. Could the tiger still walk among the living? A more exuberant thylacine observance, "Tiger Tale theatre" in Sheffield, Tasmania, reenacts a thylacine raid on a chicken coop,[44] a playfully ironic tribute to the very behavior that led to the animal's slaughter. Such events, and the sheer abundance of Tasmanian tiger imagery, from tourist T-shirts to the logo of a bus line to the Tasmanian coat of arms,[45] have rendered the thylacine a sort of dearly departed pet citizen of Australia.[46]

The spirit of National Thylacine Day was embodied for a brief time by the Rheuben Griffiths Trust. Established in 1999 in cooperation with the Australian Museum, the specific purpose of the trust was to fund research that would lead to the successful cloning of a thylacine from the tissue of a dead pup preserved in alcohol, a specimen from the museum's collection. This plan, another example of the revisionism of genome time, taps the potential for natural objects to be liberated from exhibit halls to live again via genetic and reproductive technologies. By its own account, the project made significant headway in May of 2002 when researchers, headed by Australian Museum evolutionary biologist Don Colgan, managed to replicate individual thylacine gene fragments through the common DNA cloning technique of polymerase chain reaction. This is a crucial step in a process that would involve making synthetic chromosomes of the animal's genetic make-up.[47] Despite its lack of progress since then,[48] the project's scientific importance remains high: it could lead to more and better knowledge of the reproductive genetics and biology of a number of other unique creatures indigenous to Australia, such as the numbat, an endangered marsupial anteater, and the Tasmanian devil, recently added to the "vulnerable species" list.[49] And, as Colgan notes, reflecting the same kind of nationalism as the Pleistocene Park project, the successful cloning of the thylacine would have been a "triumph for Australian science."[50]

Yet despite researchers' optimism that the thylacine's extinction "may simply be a 70-year hiccup," as the Australian Museum's news release on the breakthrough put it,[51] the thylacine cloning project is fraught with seemingly insurmountable obstacles, both scientific and cultural. For example, even if scientists ever successfully restore the thylacine's genetic structure—which they still may be able to do if they can find less degraded DNA than that derived from the museum

samples—they will then have to locate a usable ovum into which to transfer the nucleus and a viable surrogate mother who can then nurture the baby, all this from among species not much like the thylacine they are trying to restore to life. In other words, not only are there no taxonomically likely candidates available to fertilize and gestate a would-be thylacine, neither is a family available to raise it once it is born. Molecular geneticists Mike Westerman and Steve Wroe explain the main obstacle to cloning a Tasmanian tiger in terms of genetic distance from its closest relatives: "Our estimate is a minimum of 25 million years," according to Westerman, and "the chances of getting the nuclear genes of thylacines to talk to the mitochondrial genes of a [Tasmanian] devil or a quoll [the thylacine's nearest kin and possible surrogate] must be very slim."[52] Would such a cloned thylacine still be a thylacine, and if not, in what sense would the new creature continue to function as a national subject? Like immigrant human beings seeking citizenship status in a new country, a resurrected thylacine would require some sort of naturalization process to be reclaimed as Tasmania's dearly restored pet citizen. More illuminating than the scientific rationale for cloning the Tasmanian tiger, then, are the cultural cautions surrounding the success of the project, as they demonstrate better how scientific hypothesizing at the edge of the possible relies upon the imaginative speculation of narrative in the mythic mode. The Australian Museum's thylacine cloning project illustrates how solutions for problems in genetic science are sought in the mythic dimension of genome time, in which "every possible permutation" of the present opens up the possibility, however slim, that disparate genes might "talk" to one another across time—and be understood.[53]

Surprisingly, the same scientists who are skeptical about the current possibility of resurrecting the thylacine readily engage in the speculative mode that recent advances in reproductive genetics—and the mythos permeating it—make possible. For example, according to Alan Trounson, pioneering *in vitro* fertilization researcher of Monash University, "advancements in genetic engineering might allow scientists several hundred years from now to reconstruct a thylacine from scratch. With existing technologies, it should be rather routine to clone the entire genetic program of the thylacine and keep it in storage until technology catches up. The thylacine's blueprint would be preserved as an array of overlapping DNA sequences spliced into the chromosomes of *E. coli* bacteria and indefinitely maintained as a self-perpetuating 'DNA library.'"[54] Thus the "70-year hiccup" of the thylacine's extinction crisis manifests as an example of Berger's post-

apocalyptic moment "compelling expression,"[55] a need to memorialize the lost marsupial by imagining it renewed and whole again. By this logic, then, in speaking of the crisis of extinction, we are at the same time speaking of the recuperation of the lost species.

The Perils and Possibilities of Recovering the Woolly Mammoth

An examination of science journalist Richard Stone's book *Mammoth: The Resurrection of an Ice Age Giant* (2001) illustrates the tendency of genome time to telescope the crisis/renewal polarity of extinction, emphasizing the dramatic relationship of the lost animal to its environment. Despite its title, Stone's book deals as much with preserving the mythos and spectacle of the landscape in which mammoth fossils reside as it does with regenerating the animal itself. Stone's account highlights the inseparability of the animal from its homeland, which he portrays more as a matter of connection to indigenous cultures and an exhibition of man's triumph over a harsh climate than an issue of definition by geopolitical borders. In a review of *Mammoth*, John Dolan observes that Stone's account "includes enough other tales of mammoth remains found, lost, wasted, plundered, sold and otherwise mishandled to give one the sense that the mammoth is a magical, grotesque, enduring presence in Russian soil"[56]—a potent, mythic figure frozen fast in the Arctic tundra. As W.J.T. Mitchell explains in considering the nostalgia with which Thomas Jefferson and other early Americans beheld the vestigial presence of the mastodon (the woolly's cousin) on the North American continent,[57] a meditation upon an extinct beast requires a meditation as well upon its habitat—and the current inhabitants therein.

As Stone's account shows, in addition to being family restoration dramas, extinction reversal narratives can manifest in the Western tradition as adventure stories of cross-cultural contact on remote, forbidding lands. In this case, the vulnerable natives are beholden to the bold and well-funded bioprospector. Here, the peril and recovery dialectic is illuminated by stark economic disparity. The story begins with Arctic explorer Bernard Buigues' life-risking mammoth expedition in Siberia's Taimyr Peninsula and the indigenous Dolgans' expectation that his search party, which returns there regularly, will exchange "sacks of flour, shoes for the children, and other supplies to ease their hardscrabble life on the tundra" for information about the location of buried mammoth carcasses.[58] Indeed, Buigues and his crew seem to

have stepped in for the "Communist bureaucrats who used to fly out to small Dolgan villages with supplies" (78). Much like a threatened or endangered species, the Dolgans are presented as an imperiled subpopulation, though their value is less inherent and more a result of their connection to mammoth recovery in this scenario. As it turns out, the Siberian landscape is littered with the bones of mammoths and other prehistoric megafauna (36–39, 69–70, 82), which the Dolgans, like their ancestors, fashion into tools. However, it is the "greatest prize of all" (2) that Buigues is after, not merely the random scattered bones of a mammoth, nor even its profitable tusks, but an intact frozen mammoth carcass.

By Stone's account, Buigues is more than just "the latest in a long line of mammoth hunters dating back to the days of Peter the Great" (5); he has become a sort of foot soldier for science on the fringe. Buigues' transition from explorer to bioprospector began with his purchase of a pair of mammoth tusks from a Dolgan family called the Jarkovs in 1997. While Dolgans fear unearthing mammoth remains, considering it sacrilege, any bones they find above ground are fair game for building, carving, and trade (79), and the Jarkovs' find was especially lucky. Whether it was the simple lure of the forbidden, the challenge of the task, or the lucrative appeal to French TV viewers of airing a full-blown excavation, Buigues' passion to unearth a mammoth from the Khatangan permafrost was ignited by this purchase (85). Mammoth experts soon caught wind of Buigues' unfolding plan and contributed their expertise, suggesting a purpose to the excavation beyond the adventure of the dig itself. Among these experts, Japanese reproductive biologist Kazufumi Goto was most excited to assist Buigues. Having just ended an unsuccessful mammoth excavation in Cherskii—this one supported by Japanese TV—Goto and his colleagues remained intent on their goal: to retrieve preserved mammoth sperm and breed it with an Asian elephant to recreate a hybrid mammoth (53). Already, this hypothetical new creature's home was being imagined by Russian ecologist Sergei Zimov, with his Pleistocene Park plan to restore a large tract of land just outside Cherskii to mammoth steppe.

As Stone describes it, Buigues' mission in the hostile climate of the Arctic Circle gained momentum and took shape in a speculative scientific environment in which specialists like Goto and Zimov had a reproductive and preservationist stake in digging up an intact mammoth. These scientists had already worked with excavated mammoth tissue, looking for viable frozen sperm, sequencing fragments of DNA, and ascertaining whether enough mammoth DNA was available in

their samples to clone one. As in the thylacine project, a nationalist strain can be detected in Stone's treatment of this scientific discourse. Describing Russian researcher Nikoli Vereshchagin's work on the carcass of Dima, "the best preserved frozen mammoth ever found" (15), the author points out that "Vereshchagin's team was laying plans for an experiment that, if successful, would trump the American efforts and live up to the omnipresent slogan blared in meter-high block letters on the rooftops of Soviet research institutes: *Slava Sovetskoy Nauke!*—Glory to Soviet Science! What could be more glorious, after all, than cloning baby Dima?"(40)

Thus, Buigues became caught up in the small but determined international mammoth and Pleistocene Age research community and eventually secured funding for the ambitious excavation from a media outlet, the Discovery Channel, which was planning a documentary for American-based international TV. Having disregarded the Dolgans' warning not to disturb the creatures below the tundra and fighting a fierce storm that seemed nature's response to their disregard, the documentary *Raising the Mammoth* shows Buigues and his team finally managing to unearth a vast chunk of ice, perilously hauling it up out of the frozen landscape by helicopter. This satisfyingly dramatic image for the cameras captured perfectly the potent mythos of the gene in genome time: suspended in an icy cube hanging by a tether, mammoth past and future undeniably coexisted. However, like the remains of the pickled thylacine pup in the Australian Museum, the remains of the "Jarkov mammoth," as Buigues named it, were more badly deteriorated than the scientists had hoped. And, like the story of the thylacine, this one is not over. Scientists are still investigating tissue samples from the mammoth, and mammoth lovers everywhere are still consuming various versions of the mammoth resurrection in mass media.[59]

The critical response to Stone's *Mammoth* has been mixed, demonstrating a perceived need among reviewers to police the boundaries between what they consider to be reputable—that is, disinterested—science working well within the realm of the possible and the more parochial, "quixotic" science of the entrepreneurial explorer. Eric Powell, for example, writing for *Archaeology*, disparages Stone as "succumbing" to the idea—which is at best "entertainment"—that the mammoth can be cloned and might thus live again.[60] Indeed, Stone's rhetorically expedient denial at the end of his book, that woolly mammoths may still roam the remotest corners of the Arctic Circle, in effect only affirms the very possibility that they do: "What allows us to suspend our disbelief is that vanished and mythical creatures have, on occasion,

jumped from our imaginations into reality. For example, a 5-foot-long fish called the coelacanth was presumed to have gone extinct 70 million years ago. [But then] the fish were observed in the wild. Here was a living relic: proof that a species thought lost to the world could suddenly reappear" (210). What Powell and other critics fail to appreciate is that it does not matter that the coelacanth never really died out, as the woolly mammoth has; the mythos of genome time erases this difference. The implication here is the collapse of the dialectic of peril and recovery, an implosion in which delusion and inspiration, having become inseparable, make scientific effort seem fantastic and mythic endeavors real. At the crux of this collapse is the DNA molecule. Inert and lifeless, it is nonetheless poised for animation.

Extinction Revision as Transgressive Transformation

In contrast to popular accounts of science in a speculative mode, which so often read like adventure fiction, Julia Leigh's novel *The Hunter* (1999) offers the clearest view of the everyday realities of the post-apocalyptic moment after extinction and the cultural work that goes into reshaping the extinction account. Juxtaposing the tragic elements of irrecoverable family ties with a strategic amnesia of colonization's impact on the landscape, the novel starkly imagines the culturally specific wants and needs that drive extinction revision narratives. In this context, the effort to recuperate extinction is as transgressive as it is transformative: *The Hunter*'s narrative thrust derives from the biotechnology industry's profitable colonization of tissue samples, in this case those of the thylacine. Like Richard Stone's non-fictional account of the Jarkov mammoth excavation, Leigh's novel shows how economic forces intersect with and complicate the lone hunter motif. As in *Mammoth*, the novel reveals the shared space of the mythic and scientific imaginaries in extinction recuperation efforts. This is a contested space where ideas of "the natural," "the human," and "the other" intermingle, a space in which "immortality" conquers "death" thanks to gene banking and genetic modification. In addition to speculative projects to recreate Australia's "lost ark" via Jurassic Park-style technology, such as that of the Australian Museum's former director Mike Archer, this space includes the dubious commercial agenda for bioprospecting and re-engineering the DNA and reproductive tissue of rare species, the pseudoscientific elements of cryptozoology, and the competing agendas of nationalist ideals with postcolonial realities.

The narrative momentum in *The Hunter* derives from the commercial agenda to harvest the genetic material of the thylacine. According to the novel's biotech company researchers, something in the thylacine genome shows promise in biological weapons research, but whether as virus or antidote is never made clear.[61] The story begins after the alleged sighting of a thylacine by a Tasmanian National Park Service ranger, who, like the Siberian Dolgans, may profit from information about the whereabouts of his sighting once the animal is tracked down. The hunter of the novel's title is a professional bioprospector who assumes the identity of "Martin David, Naturalist," down from a university on the mainland to study Tasmanian devils. Telling the story of the thylacine hunt from M's point of view as he navigates a landscape that both absorbs and rejects him, the author offers a glimpse into the open-ended ambivalence of extinction recuperation narratives.

Although M, like his real-life counterpart Buigues, is an experienced professional who has undertaken similar bioprospecting expeditions in a variety of hostile environments, he seems taken aback by the decrepit surroundings that will serve as his base camp between expeditions. Miles and miles past the "Welcome to Tiger Town" sign outside the airport, past tracts of boarded-up houses dotting the postindustrial wasteland of a former logging operation, to the "last house at the end of the last road" (5) just before the escarpment to the Central Plateau where the thylacine supposedly dwells, M finds his point of contact with civilization in between forays into the wilderness. That point of contact is the house belonging to the woman who, in return for offering him room and board, will be compensated by the company posing as M's university research sponsor. Ironically, the woman, Lucy Armstrong, has moved from England to this ravaged landscaped to avoid the nuclear Armageddon she and her husband felt was imminent. Surrounded by junked-out cars, dilapidated outbuildings, and abandoned paddocks, the former farm is a post-apocalyptic wasteland in miniature, its primary caretaker having gone missing and presumed dead and his widow, Lucy, having succumbed to sleeping pills and the sanctuary of bed, while her two children run amok. This sad place and its pitiful inhabitants move M to doubt his mission. Does the company "want him to succeed, or is this . . . a fool's mission? Is he expendable? Yes, of course he is . . . ," he realizes (19). Early in the narrative, then, M is faced with the disagreeable role of finding meaning for his work despite his function as a mere line item in a corporate research and development budget. M's mission is further complicated by the young girl Sass's unwavering belief that her father,

Jarrah Armstrong, who was a real naturalist hunting the Tassie tiger on the same plateau that M will be ascending, is still up there and, like the thylacine, may still be alive. Thus M finds himself occupying the equally undesirable role of surrogate father to the bereft child and, eventually, to her mother and brother.

In this unsettled and unsettling backdrop, M's usual self-confidence vacillates. However, as in Stone's depiction of Buigues, who initially doubted his ability to succeed in the search,[62] M's doubt is fleeting. He has, after all, experienced narrow escapes that could have easily ended in death, and so he packs up and sets off. Climbing up to the plateau for the first time, he remembers a colleague, "another ex-soldier who had pledged allegiance to the biotech multinational" and had lost a leg in a trap set by a competitor. Could this have happened to Jarrah Armstrong out there (25–26)? More so than Stone's account of the woolly mammoth excavation effort, Leigh's novel clearly aligns the related perils of a lost species with its threatened and vanishing human seekers. M's contemplation of his role as the lone hunter suggests that this alignment in fact arises from the caprices of capital. Given his worth to the company, he wonders why they would send him out here alone:

> Was it possible the company no longer considered retrieval of genetic material a high priority? . . . He couldn't see why—what he had retrieved so far had earnt them, how much? Hundreds of millions, probably billions. The company needed him, in fact, was indebted to him. Who was of more value to a biotech company than a hunter: sampler and insurer of exclusivity. Inbred thylacine, dodo, moa, mammoth, bunyip, yeti, girls with telekinetic power, boys with an immunity to pain, the goose that laid the gold egg . . . mutations all, this was now the stuff that dreams—and wars—were made of. (50)

M thus manages to recover his lost confidence by identifying with the mythic qualities of the thylacine he is looking for, namely, its singularity and cunning. The thylacine he is hunting, M is certain, is the last living thylacine, a female who dreams of a male mate (45). "[T]here is virtue in being a survivor," he reasons. "The last tiger must be wary, she must be strong, she must be crafty and ruthless and wise. And if the mutation has endowed her with any new qualities, they must be qualities [that] enhance, not detract from, the inescapable drive to survive. Otherwise she would not be alive" (68). Despite the fact that

the mutation M ponders is the result of inbreeding, the tendency of biotech fiction to incorrectly portray genetic mutations as advantageous rather than deleterious or neutral is apparent here. It is "immortality" that "propels her day after day across the plateau," he concludes (66). M is making the (il)logical leap from isolated gene pool to everlasting existence. In the popular concept of gene banking, genes, once "invested" in this way, can triumph over destiny. M's fantasy of communing with the mythic beast begins his transformation into "the natural man," "a man with faculties so attuned that he is no longer man, is more than man" (58). Perhaps, he imagines, through the elaborate ritual of the hunt, he will become the last thylacine's mate.

M's identification with the thylacine is so great, in fact, that one reviewer remarked that "if it weren't for the tiger, [M] might not exist at all."[63] However, such intense identification with the animal he's tracking makes M at once more and less likely actually to find it. This is the common problem of confirmation bias in research—the selective attention to evidence that supports the hypothesis—a problem that looms especially large in the fringe science of cryptozoology in which M is taking part on behalf of the biotech company. Regardless of whether the cryptozoologist is on the trail of a legendary creature like the yeti or an actual creature thought to be lost like the thylacine, everything starts to look like evidence. In this instance, that classic pseudoscientific piece of evidence, the possible paw print of the lost animal, compels M beyond the trail blazed by Jarrah Armstrong, and indeed beyond whatever fate has led the real naturalist into oblivion (92).[64]

Yet M's hunt for the thylacine is already biased, on the one hand, by the monetary incentive of the biotech company and, on the other, by the competing factor of his strong identification with the animal. Here, the Tasmanian landscape itself plays a role. Neither malicious nor benign via Leigh's deft crafting—in contrast to Stone's steady engagement of the "hostile climate" motif[65]—the landscape nevertheless imposes itself between M and his goal, though still yielding useful information. M's sighting of the paw print, which he finally determines cannot be from a wombat or a wild dog, leaving only one alternative, leads to the sighting of another, and still others, but the finding is compromised by an eye injury he sustains from a tree branch coming from seemingly nowhere, "slipping under his cap, right into" it (91). Later, on a rock face, "the world drops out from underneath him and he falls," an accident that leaves him three days delirious in the snow (95–102). In this "groggy battered state," he knows he cannot trust his judgment. But being in the abyss of injury and hunger, he determines,

is not as bad as being lost (99–101). The landscape suddenly opens up in helpful ways as well. A crevice between two boulders—"he wants to call it a lair"—does not "draw [him] to it by a mysterious sixth sense or siren call" but rather strikes him as the logical end point in a culmination of evidence: a wallaby kill here, some scat there, a pile of old bones, a fresh water source, more paw prints (158–59). Making the lair his home, he thinks, "I could be quite comfortable here" (160). After months of fruitless searching, having become "the natural man," M assumes a domestic kinship with the thylacine whose lair he thinks he occupies. But as the reader can surmise from M's transgression into a state of being and dwelling that he cannot properly call his own, this marriage is, both literally and figuratively, on the rocks.

To understand the disappointing outcomes in quests to recuperate mythic beasts, both those that are undeniably extinct, like the woolly mammoth, and those that are probably so, like the Tasmanian tiger, it is helpful, as we have already seen, to consider the connection of these quests to their nationalist objectives, which tend to be idealistic and forgetful. The cryptozoological impulse in *The Hunter*, for example, derives from a sentimental nationalist reverence for the lost beast, an amnesic nostalgia among former Europeans for a pre-European reality. Yet such sentimentality is at odds with the historic Eurocentric disdain for animals that were, in this view, inferior. As Weidensaul notes, this disdain was an "extension of the racist and condescending attitude most Europeans . . . had toward Aboriginal culture."[66] We will be wise to remember the implications for non-human life of historical racism on biodiversity conservation efforts.[67] Equally important, such sentimentality is at odds with the problem of diminishing natural resources worldwide, to which the bioprospecting efforts of global biotechnology problematically contribute even while attempting to address.

In *The Hunter*, these competing forces take shape as M's fantasy of being the conqueror eventually gives way to a fantasy of identifying with the conquered and, finally becoming, like the thylacine, prey to thylacine hunters. As it turns out, this is more than mere fantasy. If M is not exactly being hunted, he has at least come under surveillance by the time he has made several trips up to the plateau and back again for supplies. The townspeople distrust him, at one point mistaking him for a National Parks ranger without the uniform (139). But it is obvious that he is not a Parks Service employee, as he works alone and has a different motive: to trap and possibly kill a thylacine, rather than merely to photograph or tag one. The townspeople deduce his motive from M's excursions to the local butcher to purchase sheep heads and other offal for his tiger traps.

The rangers in the novel serve as an illuminating foil to M's solitary hunt, for, having accepted the probable extinction of the thylacine, their work is much easier than his. Representing the Australian national interest in conservation, they understand the animal's mythos in the larger context of its value as a cultural icon, which its loss has made possible. Like M, their jobs, too, depend on the thylacine's absence, but unlike M, who has pledged allegiance to the profitable biotech multinational, the underpaid Australian park service rangers need only confirm the obvious: the Tassie tiger is gone. To M, an experienced bioprospector with a more finely honed set of skills, the unskilled rangers' noisy campouts threaten to drive his shy thylacine away. As if to prove to himself what he perceives as the rangers' poor powers of observation and overall unsuitability for their job, M trails a pair of them for several days, eavesdropping on their conversations at night and stealing food from their camp by day, all without their notice.

M in fact knows these two rangers. Devotees of the mysteriously disappeared naturalist Jarrah Armstrong, the young men have camped out in Armstrong's backyard, M's base camp. "The immortals," as M has come to think of them, are part of a loose-knit group of environmentalists organized around the legacy of the missing naturalist; their founding document is Armstrong's book *Bioethics for Another Millennium.* M's intuition of their "immortality" is apt, given their disregard for the corporeal. By the immortals' interpretation of Armstrong's treatise, natural history works something like this: "Everything is about energy . . . , it's all about transformation of energy . . . . Jarrah Armstrong had it right: energy and matter, that's what it's all about. No beginnings and no ends" (106–07). As a model of conservation, this interpretation of natural history is open-ended, allowing for loss as necessary to change: extinction as a process of evolution, evolution as inevitable and ongoing, the only ethical imperative being to document the process. By contrast, M has taken great pains to intervene in the process for the global biotech company. Unlike the immortals, he recognizes the more complex ethics involved in the potential of human beings both to destroy and to recreate the natural world. M lives in this millennium, not some other. Still, he cannot quite give himself over to the currency of genome time, clinging to the closed scientific model in which extinction is a finite event that demarcates a "before" and an "after" for species. "If everything is transformed," he wonders, pondering the immortals' discussion, "then what is extinction?" (107). M's ontological puzzlement over the natural world revised by genome time—underscored by the stark, anthropocentric polarity of peril and recovery—resonates in *The Hunter* as the novel's central question.

In the end, unable to locate the elusive thylacine, M instead comes to embody the powerful presence of loss signified by the extinct animal and, indeed, the consuming loss signified by extinction itself: "Once it has a grip on you, absence, it cannot be defeated—how can you fight against nothing . . . " (133)? In experiencing first-hand the loss of the thylacine, he experiences the loss of the Armstrong family as well. Having been called off the fruitless, months-long mission by the biotech company, M nevertheless requests to go back to Tasmania, the hunt, and the Armstrong family. Upon returning to the "last house at the end of the last road," however, he finds it abandoned, its inhabitants missing and its furniture gone. A burned patch of carpet in front of the fireplace offers the only clue as to what might have happened. The news, he finds out back in town, is grim: Sass has been badly burned in a fire, the young boy has been fostered out, and Lucy has sunk deeper into her depression, requiring hospitalization. Ironically, Lucy's immigration to the land Under Down Under to avoid the possibility of nuclear fallout could not spare her from life's more routine catastrophes. This sad news strikes M as a sign of a "new world with which he cannot engage, [with] rules [that] are not his rules" (135). And so, at the narrative's end, he renews his quest for the thylacine and sets off after it again, retreating from the "fight against nothing" to the simpler game of searching for a mythical beast in an unpeopled landscape.

The Paradox of Extinction in Genome Time

Narratives that imagine the impact of genetic science on lost species reflect new ways of regarding the role of the human in natural history. As M's final decision in *The Hunter* illustrates, adapting to this role is not easy for human beings. By understanding DNA as a historical repository containing "every possible permutation of time as a suddenly legible system of signs,"[68] we understand *Homo sapiens* as just another species with the potential to be both lost and found, at once finite and ongoing. Equally important, we are forced to adjust our notions of species change—not merely evolutionary but also cultural—to this new understanding. Perhaps most significant of all, these are facts over which we have only partial control through biotechnology. And, as species recuperation narratives in general suggest, the prospect of mastery over genome time is a tantalizing one.

So far, extinction has been the fate only of non-humans and proto-humans, but we *Homo sapiens* fear that it may one day be our

fate as well. Indeed, in Darwinian terms, our non-existence as a species is inevitable, and we dwell on our post-human future, imagining it genetically superior, or more digital than biological—anything to keep the story going. This anxiety further fuels our interventions into extinction, coloring the stories we tell about it. The questing hero in service to science and technology; the harsh, primeval landscape; the enigmatic, vaguely threatening locals, with their quaint self-identifying practices; and, of course, the biological traces of the elusive object of the quest, the missing animal—these are the archetypal elements of extinction anxiety. We can add to these archetypal elements such emerging features of extinction narratives as the post-apocalyptic refusal of endings, including the idea that extinction is merely a kind of evolutionary change; a fascination with anachronism, as in the possible coexistence of non-contemporaneous species; a desire to identify new kinships among species to increase breeding potential; even a sense that human beings might be a kind of parasitic, "resident alien" on the planet, more than vaguely threatening to the "locals."

To some extent, the stories we tell ourselves about extinction must be read, like other dystopian narratives, as cautionary tales of forgotten histories and unpredictable consequences. Yet utopian opportunities for recovery and transformation in these narratives also proliferate, substantiated in such scientific projects as Pleistocene Park and thylacine genome sequencing. Examining the polarization of dystopian/utopian elements in narratives featuring genetic science can provide insight into our strategies of adapting to a new understanding of time as molecular and perpetually present in DNA. Seen as thought experiments, then, such narratives—and their analyses—should be encouraged. Because the effect of genome time is to erase traditional boundaries, the expressive forms most useful in this regard will be those that challenge boundaries between the human and the non-human, between the "nature" of the DNA molecule and the "nurture" of our engagement with it, between the temporal and the spatial, and between cultures of science and the activities of the rest of the world. Especially helpful here are representations of scientific activity as politics in which the negotiation involved in scientific problem solving is clearly portrayed. Two examples that come to mind are Greg Bear's novel *Darwin's Radio* (1999) and its sequel, *Darwin's Children* (2003), and the Critical Art Ensemble's performance piece "GenTerra." Bear's novels envision the political struggle over whether and how to recognize a new hominid species, *Homo sapiens novus*, a genetic revival of the extinct Neanderthal. "GenTerra" invites participants to appraise the risks and benefits

of creating transgenic life forms through a broad critical examination of resource management practices, responses to non-native species proliferation, and longstanding myths of monsters. As these and other thought experiments flourish, imaginative scientists and cultural critics are better understanding how "extinction" signifies a stepping-off point for human stewardship of the natural world: a real event requiring work, an incredible idea inducing dreams.

NOTES

1. Ryall, "Japanese Professor."

2. Zimov, "Pleistocene Park: Return of the Mammoth's Ecosystem," 796; Zimov, Chapin, and Chapin, "Pleistocene Park: Re-Establishment of a Functional Steppe Ecosystem in Northeast Siberia," under "Summary."

3. Dan Gallagher's self-published novel *The Pleistocene Redemption* (1997) describes an Iraqi experiment to clone all sorts of Pleistocene Age mammals, including early hominids, as biological warfare agents. An early example of an account of cloning a woolly mammoth occurred in a 1984 hoax article in MIT's *Technology Review*, "Retrobreeding the Woolly Mammoth," by Diana ben-Aaron; see Grant and Olender, "Cloning: Legend, Science Fiction and Fact." Like the current discussion among Russian and Japanese scientists, this account includes a plan to incorporate the new creature into the Soviet economy as the equivalent of tow trucks on the Trans-Siberian highway.

4. Boulter, *Extinction: Evolution and the End of Man*, 159.

5. Ibid., 161, 176.

6. Zimov, "Pleistocene Park: Return of the Mammoth's Ecosystem," 796.

7. Ibid., 797.

8. Wayne and Morin, "Conservation Genetics in the New Molecular Age."

9. Nee and May, "Extinction and the Loss of Evolutionary History," 692.

10. United States Fish and Wildlife Service, *The Endangered Species Act of 1973*, sec. 3.

11. Ibid.

12. Ibid.

13. Ibid., sec. 2.

14. Convention on International Trade in Endangered Species of Wild Fauna and Flora.

15. H.R. 1299, the Critical Habitat Enhancement Act of 2005, was intended to "reform the process for designating critical habitat." H.R. 1837 was intended to "establish limitations on the designation of critical habitat."

16. Zimov, "Pleistocene Park: Return of the Mammoth's Ecosystem," 797.

17. Boulter, *Extinction: Evolution and the End of Man*, 170–71.

18. Leakey and Lewin, *The Sixth Extinction: Patterns of Life and the Future of Humankind*, 234–45.

19. Berger, *After the End: Representations of Post-Apocalypse*, 5.

20. Jameson, "'If I Find One Good City I Will Spare the Man,'" 231.

21. Willerslev, et al., "*Diverse Plant and Animal Genetic Records from Holocene and Pleistocene Sediments*."

22. According to Thacker, DNA should be understood as "biomedia," simultaneously material and informatic and coexisting in all sorts of media, *Biomedia*, 11–15. Biodiversity science, population genetics, and genetic medicine all rely on

data-intensive DNA sequencing and complex computational modeling; see also Bowker, "Biodiversity Datadiversity."

23. Thacker, *Biomedia*, 13.

24. Clayton, "Genome Time," 33.

25. Ibid.

26. Boulter, *Extinction: Evolution and the End of Man*, 22.

27. Stone, "A Bold Plan to Re-Create a Long-Lost Siberian Ecosystem."

28. Clayton, *Charles Dickens in Cyberspace*, 189.

29. Zoological Society of San Diego, *Center for Reproduction of Endangered Species*.

30. Haraway, *Modest Witness@Second Millennium. FemaleMan©_Meets_OncoMouse™*, 44.

31. Lanza, et al., "Cloning Noah's Ark."

32. Rothfels, "Immersed with Animals," 211.

33. Salsberg, "Resurrecting the Woolly Mammoth," 17.

34. The haunting metaphor permeates scientific and popular discussions of extinct species. Paul S. Martin and his colleague David Burney, both experts on extinction in North America, are quoted as saying that Americans live "in a continent of ghosts" (Stone, *Mammoth*, 182) because of the mass die-off that occurred on the continent at the end of the Pleistocene Age (182). And popular science writer Connie Barlow, writing in *The Ghosts of Evolution: Nonsensical Fruits, Missing Partners, and other Ecological Anachronisms*, examines the idea that current species are "haunted" by the "ghosts" of their extinct relatives, with whom they are adapted to coexist.

35. MacPhee, *Extinctions in Near Time*.

36. Salsberg, "Resurrecting the Woolly Mammoth," 51; Stone, *Mammoth*, 7–13.

37. Tourism Tasmania, *Tasmanian Tiger*.

38. Campbell, Thylacine Museum. See also naturalist Scott Weidensaul's historical account of the thylacine's demise ("Death of a Species"), to which rampant disease in dwindling populations might also have contributed.

39. Weidensaul, "Death of a Species."

40. Quoted in Woodford, "Get a Life, Scientists Tell Extinct Tiger," par. 11.

41. Woodford, "New Bush Sighting Puts Tiger Hunter Back in Business," par. 5.

42. Weidensaul, "Raising the Dead," par. 23.

43. Benjamin was actually a female thylacine, not a male, as is commonly thought; see Campbell, Thylacine Museum.

44. Tourism Tasmania, *Tasmanian Tiger*.

45. Leigh, "Back from the Dead," par. 2.

46. The posthumous symbolic citizenship of the Tasmanian tiger is comparable to the flagship species status of early elephants in North America, according to Paul Martin; see Stone, *Mammoth* 183.

47. Biotechnology Australia, *The Thylacine: A Case Study*, par. 5.

48. The Australian Museum's former director Mike Archer announced in February 2005 that it would end the thylacine cloning project; see Skatsoon, "Thylacine Cloning Project Dumped."

49. According to Tasmania's Department of Primary Industries and Water, the Tasmanian devil is now a "vulnerable species" under the State's Threatened Species Protection Act of 1995 due to the spread of Devil Facial Tumor Disease.

50. Quoted in Taggart, "Cloned Back to Life?", par. 6.

51. Firminger, "Tasmanian Tiger Cloning Breakthrough," par. 4. republished http://www.mysteriousaustralia.com/thylacine_breakthroughs.html.

52. Quoted in Campbell, Thylacine Museum.

53. In another example of this characteristic of genetic science in the speculative mode, scientists pondering how to save the bucardo entertained the idea

of creating a molecular sex-change in one of the clones of the last living bucardo in order to increase their prospects of reintroducing this species through selective breeding with near-relatives; see Lee, "Can Cloning Save?"

54. Campbell, Thylacine Museum.

55. Berger, *After the End*, 5.

56. Dolan, "Thaw Me a Mammoth."

57. Mitchell, *Last Dinosaur*, 116–23.

58. Stone, *Mammoth*, 1–2. Subsequent references are cited parenthetically in the text.

59. One of the more recent incarnations of the woolly mammoth excavation rage occurred in the 2005 World Exposition in Aichi, Japan. There, the recovered remains of the Yukagir mammoth, excavated in Siberia during 1994, were on display in a refrigerated case. A prominent finding during this excavation project is the complete sequencing of the mitochondrial DNA of this animal; see Japan Association for the 2005 World Exhibition. Discovery Channel has also capitalized on the entertainment value of the thylacine restoration project in its documentary *The End of Extinction: Cloning the Tasmanian Tiger*, see Firminger, "Tasmanian Tiger Cloning Breakthrough."

60. Powell, "Mammoth Distortions."

61. Leigh, *The Hunter*, 40. Subsequent references are cited parenthetically in the text.

62. Buigues questioned his participation in the mammoth excavation at first: "Many times, I thought, What am I doing here, spending this money? . . . I was really depressed" (Stone, *Mammoth*, 83).

63. Gordon, Review of *The Hunter*.

64. See Weidensaul, *The Ghost With Trembling Wings*, 38–92, for an explanation of the cultural and pseudoscientific logic of cryptozoology.

65. In fairness to Stone's journalistic ability, the "hostile climate" motif in woolly mammoth excavation accounts plays a significant role in scientific hypothesizing about the role of climate change in mammoth extinction.

66. Weidensaul, *The Ghost With Trembling Wings*, 262.

67. The legacy of racism in bioprospecting has been construed as a kind of colonialism; see, for example, Moran, King, and Carlson.

68. Clayton, "Genome Time," 33.

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